

# The relevance of equal splits — On a behavioral discontinuity in ultimatum games

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## Abstract

The findings on the ultimatum game are considered as belonging to the most robust experimental results. In this paper we present a slightly altered version of the mini ultimatum game of Bolton and Zwick (1995). Whereas in the latter exactly equal splits were feasible in our games these were replaced by nearly equal splits favoring (slightly) the proposer in one version and the responder in a second version. Such a minor change should not matter if behavior was robust. We found, however, a behavioral discontinuity in the sense that fair offers occur less often when equal splits are replaced by nearly equal splits. This has implications for theories incorporating fairness into economics.

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## 1. Introduction

The findings on the ultimatum game (see Roth (1995) for a survey) are considered as belonging to the most robust experimental results. Bolton and Zwick (1995), for example, have shown that essential behavioral regularities like responders' willingness to reject unfair offers and proposers' propensity to offer equal splits pertain in ultimatum games in which only two offers, a fair one and a unfair one, are feasible. Here we investigate such 'mini ultimatum games' in which the 'fair offer' can be slightly unfair. If behavior was robust, such small payoff changes should not matter. But, in fact, they do. Replacing the equal split by a 'nearly equal split' dramatically changes behavior. In particular, the fair outcome is chosen less frequently.

To be more specific, we investigated three mini ultimatum games, one in the fashion of Bolton and Zwick and two others in which we replaced the equal split by offers once slightly favoring the proposer and once slightly favoring the responder. Moreover, we implemented a 2-by-2 factorial design concerning the methods of eliciting behavior.

The natural way of implementing a game with sequential moves is, of course, to let subjects play it sequentially. Then, however, some information sets may be seldomly reached what makes it difficult to get a sufficient database. To economize on subjects many experimenters apply the so-called strategy method by simultaneously asking all players for decisions at *every* information set. This procedure can also reveal more information about the true motivations of a single subject. But there is a caveat. Roth (1995, 322–323) who provides a discussion of the pros and cons of the strategy method writes: “The obvious disadvantage is that it [the strategy method] removes from experimental observation the possible effects of the timing of decisions in the course of the game.”<sup>1</sup> Furthermore, he points out that the strategy method “forces subjects to think about each information set in a different way than if they could primarily concentrate on those information sets that arise in the course of the game.” He concludes that applying the strategy method “amounts to a significant change in the game itself,” and argues that there is some need to explore “for which kinds of games there may be significant differences in observed behavior when the strategy method is used.”

A similar problem arises when subjects participate not only in one game but in many games. Relying on a full a 2-by-2 factorial design (sequential play versus strategy method and one versus many games) we studied the games at hand and found a clear-cut result. Only the natural design, in which subjects play one

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<sup>1</sup>Evidence for the relevance of the timing of decisions is provided by Rapoport (1997).

game sequentially, reveals the behavioral relevance of exactly equal splits. All other designs which economize on subjects fail to produce the same behavioral pattern.

The remainder of the paper is organized as follows: In Section 2 we introduce the experimental design in more detail. In Section 3 we present the main behavioral regularities and Section 4 concludes.

## 2. Experimental design

The three mini ultimatum games we explore are represented in Figure 2.1.

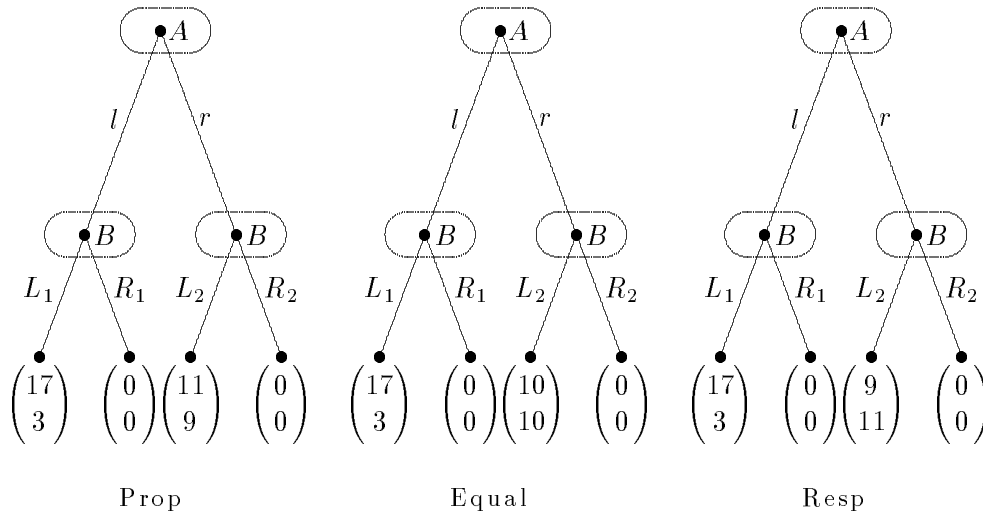


Figure 2.1: The three games

First player  $A$  chooses between  $l$  and  $r$  and then, depending on  $A$ 's choice, player  $B$  chooses between  $L_1$  and  $R_1$ , respectively between  $L_2$  and  $R_2$ . The three games only differ in the payoffs for the path  $(r, L_2)$ . For the variant corresponding to Bolton and Zwick (1995) this path assigns equal payoffs to both players.<sup>2</sup> We refer to this game as Equal. In game Prop player  $A$ , the proposer, receives 11 and player  $B$ , the responder, gets 9, in case of  $(r, L_2)$ , whereas for game Resp this

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<sup>2</sup>Note that the payoff vector  $\begin{pmatrix} 17 \\ 3 \end{pmatrix}$  corresponds to the payoff vector  $\begin{pmatrix} h_{4,1} \\ h_{4,2} \end{pmatrix} = \begin{pmatrix} h_{9,1} \\ h_{9,2} \end{pmatrix} = \begin{pmatrix} 3.40 \\ 0.60 \end{pmatrix}$  of Bolton and Zwick (1995) since  $\begin{pmatrix} 17 \\ 3 \end{pmatrix} = 5 \cdot \begin{pmatrix} 3.40 \\ 0.60 \end{pmatrix}$ .

Mode	Sequential Play	Simultaneous Play
One Game Only	SeqOne (96)	SimOne (77)
All Three Games	SeqAll (20)	SimAll (19)

Table 2.1: The 2-by-2 factorial design of eliciting choices and the numbers of subjects participating in the four treatments.

is reversed. (We will refer to the games Prop and Resp also as the ‘inequality games’ in contrast to the ‘equality game’.)

In game Prop both offers, if accepted, imply a payoff advantage for player  $A$ , the proposer, whereas in game Resp the proposer can either make an unfair offer or one which slightly favors the responder. Only in game Equal the proposer’s choice is one between offering an unfair allocation or offering strict equality. If players are only guided by monetary incentives, the solution of all three games is, of course, the unique subgame perfect equilibrium  $s^* = (l, (L_1, L_2))$ .

Concerning the method of eliciting choices we distinguish between sequential and simultaneous play (reflecting the difference between the extensive form game of Figure 2.1 and the corresponding normal form game) and we distinguish between a between-subjects design in which each subject plays only one game and a within-subjects design in which each subject plays all three games. Both aspects together establish the 2-by-2 design shown in Table 2.1. Table 2.1 also indicates the numbers of subjects who participated in the four treatments.

The (translated) instructions for all four variants which introduce the game graphically as in Figure 2.1 can be found in the Appendix. All participants were undergraduates in economics without training in game theory, but some basic knowledge of neoclassic theory. We neither provided any training before the experiment nor did we repeat the experiment since we are mainly interested in whether small amounts of inequality can change the usually very robust first-round behavior in ultimatum games.

### 3. Results

We first present the results of treatment Seqone in which subjects sequentially played one game. This is the most natural implementation of the given extensive form games. Behavioral patterns observed in this treatment should be seen as genuine for the games and should serve as a benchmark for the other treatments.

Table 3.1 shows the choices of the 96 subjects who participated in Seqone.

Game	Decisions					
	Proposers		Responders			
	$l$	$r$	$L_1$	$R_1$	$L_2$	$R_2$
<i>Prop</i>	9	8	7	2	8	
<i>Equal</i>	5	10	2	3	9	1
<i>Resp</i>	12	4	5	7	4	

Table 3.1: Behavior in treatment Seqone

The first observation which is immediately falling upon is that subjects reacted to the small payoff changes in a quite dramatic fashion. Replacing the equal split by a nearly equal split makes an important difference. This can be statistically validated. Proposers choose significantly less often the ‘fair offer’  $r$  when the equal split is replaced. Comparing their behavior in both inequality games with their decisions in the equality game shows that the patterns are significantly different with  $p = .05$  ( $\chi^2 = 3.81$ ). Moreover, it can be seen that proposers react stronger if the equal split is replaced by a nearly equal split favoring the responder. Whereas in game Equal two thirds of the proposers choose the fair offer, only one quarter does the same in game Resp what is significant with  $p = .02$  ( $\chi^2 = 5.42$ ).

Responder behavior is more difficult to summarize. Virtually all responders accept, of course, the fair offer  $r$ , i.e. they choose  $L_2$  when being asked. More interesting is how responders react to the unfair offer. Due to sequential play the number of observations here is much smaller than it has been for the proposers. Nevertheless, one can see that the rate of rejections is considerably lower in game Prop than in the other two games. This difference is also statistically valid ( $p = .076$ ,  $\chi^2 = 3.15$ ).

We sum up our observations by formulating two behavioral regularities.

**Regularity 1.** *Proposers choose more often the unfair offer when the equal split is replaced by a nearly equal split. This effect is particularly strong when the nearly equal split favors the responder.*

**Regularity 2.** *Responders reject unfair offers less often when all agreements imply a payoff advantage for the proposer.*

As argued in the introduction the two inequality games are generated by slightly altering a single payoff vector of the equality game. Our results show that behavior is not robust with respect to these small changes. How can this be explained? Looking at the two inequality games separately we get some clues: The data of game Resp seems to indicate that envy may play an important role and

may overcompensate a general fairness concern (proposers may simply hate the idea of receiving less than their opponent). In contrast, in game Prop proposers may have felt especially strong since all allocations implied an advantage for them. If proposers expected responders to share this view and if someone feeling weak is more likely to accept unfair offers, i.e. if proposers anticipated Regularity 2, it makes perfect sense for them to be less afraid of rejections and to choose the greedy offer.

Normative theories are capable of incorporating such effects. There are attempts to use utility functions that depend both on absolute and relative payoffs (see Bolton, 1991, and Bolton and Ockenfels, 1997). What our results suggest is that if we fix the absolute payoff the changes in utility with regard to relative payoff are dramatic in the neighborhood of the exactly equal split: Utility should sharply increase at the left of the equal split and steeply decline at the right of the equal split.

Alternatively, one could explain our observations by a discontinuity in perception and behavior of individuals. It might be that fairness considerations are only triggered if an equal split is *feasible*. Splitting equally plays an important role in our upbringing. Typically, our first “bargaining experiences” with siblings and friends are situations where sharing equally is quite common (often enforced by third parties like parents or teachers).

Next we turn to the methodological question whether one can obtain the same behavioral patterns by either gathering more data and/or economizing on subjects with the strategy method. Tables 3.2 and 3.3 summarize the observations obtained from all 208 subjects who participated in the four treatments. The results are devastating. Tables 3.2 and 3.3 show that the patterns obtained in SeqOne vanish completely in all other treatments. In fact, there are virtually no differences between the three games in each of the other three treatments. Since this is true for both players we conclude by

**Regularity 3.** *Whereas there are significant differences in behavior across games when only one game is played sequentially these differences do not exist in all other modes of eliciting choices.*

Although all treatments other than SeqOne level off the differences between the three games they do it in different ways. Two effects seem worthwhile mentioning. On the one hand, proposers choose more often the fair offer when deciding in all games than when deciding only in a single game. On the other hand, responders reveal a higher willingness to reject unfair offers when the games are played sequentially as compared to simultaneous play.<sup>3</sup>

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<sup>3</sup>Neglecting dependency of observations the latter result can be statistically validated on an

Game	Mode and Moves							
	SeqOne		SeqAll		SimOne		SimAll	
	<i>l</i>	<i>r</i>	<i>l</i>	<i>r</i>	<i>l</i>	<i>r</i>	<i>l</i>	<i>r</i>
<i>Prop</i>	9	8	4	6	9	4	4	5
<i>Equal</i>	5	10	4	6	7	6	3	6
<i>Resp</i>	12	4	5	5	7	6	5	4
$\Sigma$	26	22	13	17	23	16	12	15

Table 3.2: Proposers' behavior (summarised)

Game	Mode and Moves															
	SeqOne				SeqAll				SimOne				SimAll			
	<i>L</i> <sub>1</sub>	<i>R</i> <sub>1</sub>	<i>L</i> <sub>2</sub>	<i>R</i> <sub>2</sub>	<i>L</i> <sub>1</sub>	<i>R</i> <sub>1</sub>	<i>L</i> <sub>2</sub>	<i>R</i> <sub>2</sub>	<i>L</i> <sub>1</sub>	<i>R</i> <sub>1</sub>	<i>L</i> <sub>2</sub>	<i>R</i> <sub>2</sub>	<i>L</i> <sub>1</sub>	<i>R</i> <sub>1</sub>	<i>L</i> <sub>2</sub>	<i>R</i> <sub>2</sub>
<i>Prop</i>	7	2	8		2	2	6		8	5	13		6	4	10	
<i>Equal</i>	2	3	9	1	2	2	6		8	4	12		7	3	9	1
<i>Resp</i>	5	7	4		2	3	5		10	3	12	1	7	3	10	

Table 3.3: Responders' behavior (detailed)

## 4. Discussion

We designed three mini ultimatum games which vary only in one payoff vector following the acceptance of the (almost) fair offer. In one version an exactly equal split of the pie was feasible. In two other versions the exactly equal split was replaced by a nearly equal split, once slightly favoring the proposer and once slightly favoring the responder. Comparing the equality game with the inequality games we observed a behavioral discontinuity in the sense that behavior changed dramatically although the inequality games were generated by only slightly altering a single payoff vector of the equality game. More precisely, proposers make significantly more often unfair offers when the exactly equal split is not feasible. Responders reject unfair offers less often when the almost fair offer implies a slight payoff advantage for the proposer. Moreover, there is hardly any willingness to reject nearly equal splits, i.e. minor inequalities are not annoying enough to induce conflict.

In the light of Regularity 3 an important message of our study is that experimental observations depend crucially on the method of eliciting choices. Experimenters have to keep in mind that one possibly has to pay a high price for gathering more data and economizing on subjects by using the strategy method

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aggregate level ( $p = .1$ ,  $\chi^2 = 2.81$ ).

or confronting participants with more than one game.

## References

- [1] Bolton, G. E. (1991): A Comparative Model of Bargaining: Theory and Evidence, *The American Economic Review*, 81, 5, 1096-1136.
- [2] Bolton, G.E. and Ockenfels, A. (1997): ERC: A Theory of Equity, Reciprocity, and Competition, *Working Paper*, Penn State University.
- [3] Bolton, G. E. and Zwick R. (1995): Anonymity versus Punishment in Ultimatum Bargaining, *Games and Economic Behavior*, 10, 95-121.
- [4] Roth, A.E. (1995): Bargaining Experiments, in: *Handbook of Experimental Economics*, eds. J.H. Kagel and A.E. Roth, 253-348.
- [5] Rapoport, A. (1997): Order of Play in Strategically Equivalent Games in Extensive Form, *International Journal of Game Theory*, 26, 113-136.



## Appendix

### A. Detailed data of modes

For the data observed in mode SeqOne see Table 3.1.

Game	Proposer		Responder			
	$l$	$r$	$(L_1, L_2)$	$(L_1, R_2)$	$(R_1, L_2)$	$(R_1, R_2)$
<i>Prop</i>	9	4	7		5	
<i>Equal</i>	7	6	7		4	
<i>Resp</i>	7	6	9		2	1

Mode SimOne: One game, simultaneously

Proposer		Responder	
$\#(r, r, r) = 5$	$\longrightarrow$	$\#(L_2, L_2, L_2) = 5$	
$\#(l, l, l) = 4$	$\longrightarrow$	$\#(R_1, R_1, R_1) = 2,$	$\#(L_1, L_1, L_1) = 2$
$\#(r, r, l) = 1$	$\longrightarrow$	$\#(L_2, L_2, R_1) = 1$	

Mode SeqAll: All three games, sequentially (Prop , Equal , Resp )

Proposer	Responder
$\#(r, r, r) = 3$	$\#((L_1, L_2), (L_1, L_2), (L_1, L_2)) = 5$
$\#(l, l, l) = 2$	$\#((R_1, L_2), (R_1, L_2), (R_1, L_2)) = 2$
$\#(r, r, l) = 2$	$\#((R_1, L_2), (L_1, L_2), (R_1, L_2)) = 1$
$\#(l, r, r) = 1$	$\#((R_1, L_2), (R_1, L_2), (L_1, L_2)) = 1$
$\#(l, r, l) = 1$	$\#((L_1, L_2), (L_1, R_2), (L_1, L_2)) = 1$
$\#(r, l, l) = 1$	

Mode SimAll: All games, simultaneously (Prop , Equal , Resp )

### B. Translated Instructions

[Those parts of the instructions being only relevant in the All treatments are in brackets.]

*Please read the following instructions carefully! In case of questions raise your hand! We will answer all questions privately.*

Welcome to our experiment! As you will see in a moment you can earn some money. How much depends on what you will do and on what somebody else with whom you will be randomly matched will do. The rules are quite simple. Look at the following decision tree(s).

[Figure(s) of relevant game tree(s).]

(In all three situations) First A decides whether to choose “r” or “l”. After A has made his choice, B has to decide. Depending on A’s choice, B either has to choose between “L1” and “R1” or between “L2” and “R2”. Four cases are possible:

A chooses “l”, B chooses “L1”: In this case A receives DM 17 and B receives DM 3 (all situations).

A chooses “l”, B chooses “R1”: In this case both receive nothing (all situations).

A chooses “r”, B chooses “L2”: In this case A receives DM [amount according to game] and B DM [amount according to game]. [In the All treatments this sentence was repeated for all situations.]

A chooses “r”, B chooses “R2”: In this case both receive nothing (all situations).

In case you are A, please make your choice between “l” and “r” by drawing a small circle around the letter. (Do this for all three situations.)

[Next paragraph only for Sim treatments:] In case you are B, please make your choice between “L1” and “R1” for the case A chooses “l” *and* make your choice between “L2” and “R2” for the case A chooses “r”. Do this by drawing two (six) circles indicating your decisions. This means that every A has to draw one (three) circle(s) and every B has to draw two (six) circles.

[Next paragraph only for Seq treatments:] A’s decisions sheet will then be passed to a randomly chosen B. Knowing A’s decision B has to make his choice, i.e. if A has chosen “l”, B has to choose between “L1” and “R1”; and if A has chosen “r”, B has to choose between “L2” and “R2”. As a B do this by drawing a small circle around the label of your choice. (Do this for all three situations!)

[Next paragraph only for Sim treatments:] After having collected all decision sheets we will pair A’s and B’s randomly to determine your payoffs.

To ensure your anonymity you receive a code number on a separate card. Please write your code number in the appropriate box on your decision sheet and keep your code card. You will receive your payoff only for showing this card. This procedure ensures your anonymity with respect to us and to the participant you are matched with.

You have role [A/B].